

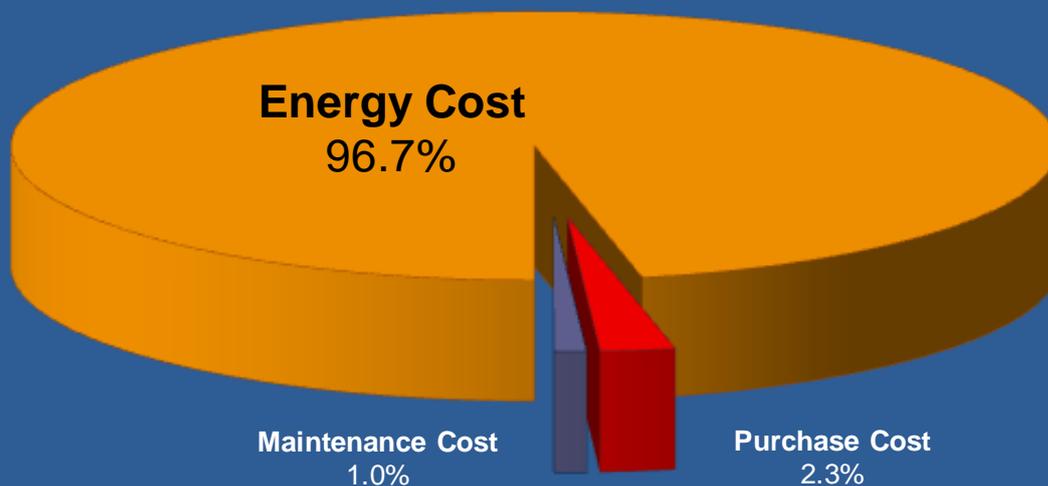


## A Guide to Selection of Efficient Motors & Controls

The purpose of this guide is to assist the end user in the selection of the best Motor and Control technology for a given application. It addresses the differences in motor efficiency ratings, the considerations and benefits of different control methods, and the issues that affect the decision making process for fixed or variable speed control.

### Running Cost vs Purchase Cost

The cost of buying an electric motor can be deceptive; in a single year the cost of energy can be up to 10 times the purchase cost. Over the life of the motor it is by far the most significant cost.



11 kW IE3 motor, 4000 operating hours per year, 15 year life cycle  
Source: EuP Lot 11, 2008

There are a number of ways of reducing these energy costs that more than pay for themselves. The purpose of this guide is to help make the right decisions on selecting the most efficient motor & control combination for the application.

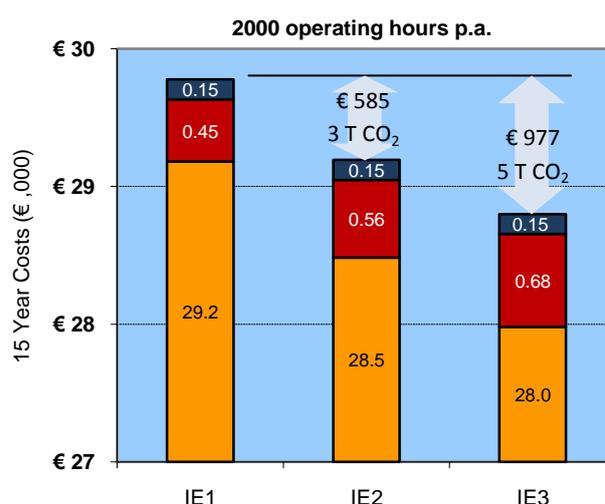
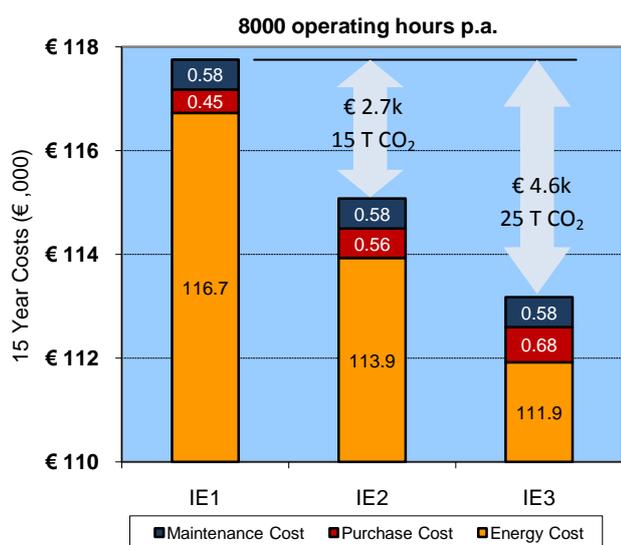
## Motor Efficiency

As motors have evolved, manufacturers have achieved greater efficiencies by the use of improved design, production techniques and materials. This now presents the user with a range of motor designs that offer different levels of efficiency.

The International Electrotechnical Commission (IEC) has published an international standard that defines 3 distinct energy efficiency classes for single-speed, three-phase motors (IE1, IE2, IE3). This standard has also been adopted as a European and UK Standard (BS EN 60034-30:2009). IE4 efficiency class is also in development. The IE classes replace the previous CEMEP EFF classes.

<b>IE1</b>	Standard Efficiency	<b>EFF2</b>
<b>IE2</b>	High Efficiency	<b>EFF1</b>
<b>IE3</b>	Premium Efficiency	-
<b>IE4</b>	Super Premium Efficiency	- (future development)

Higher efficiency motors cost more to purchase because of the more intensive production techniques and additional material costs. However, the saving in operating energy costs can often offset the higher capital cost as shown in the graphs below.



Graphs for an 11kW 4 pole motor. Source: EuP Lot 11, 2008  
Energy costs adjusted to €0.10 per kWh

At 8000 operating hours per year, the additional cost of an IE2 motor is paid back in 7 months, with an IE3 motor paying back in 10 months. Even at only 2000 operating hours per year, the energy saving repays the capital in about 3 years.

The European Ecodesign Directive\* sets out mandatory minimum energy efficiency requirements for motors that can be placed on the market.

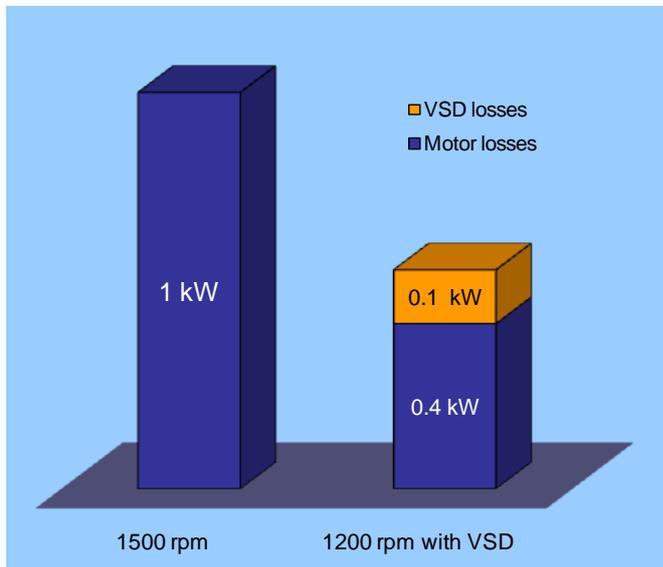
Date	Motor Range	Minimum Efficiency Standard
June 2011	0.75 kW to 375 kW	IE2 (with fixed or variable speed control)
January 2015	7.5 kW to 375 kW	IE3 (with fixed or variable speed control) or IE2 with Variable Speed Drive
January 2017	0.75 kW to 375 kW	IE3 (with fixed or variable speed control) or IE2 with Variable Speed Drive

\* The Ecodesign Directive (2009/125/EC) includes EuP (Energy Using Products) and ErP (Energy Related Products)

## Variable Speed Drives

Many applications can benefit from the use of Variable Speed Drives (VSD) to better match the speed of the motor to the driven machinery. This can result in significant energy savings in addition to improved process control, reduced maintenance, longer system life, very soft start, improved flexibility, integration into automation systems, reduction in audible noise and increased performance.

Typical applications that benefit from a VSD include most fans and pumps, turbo compressors and material handling amongst others.



The relatively small losses in the Variable Speed Drive are easily compensated for by the overall improvement of the application efficiency

To recoup the capital cost of a typical 11kW VSD only a modest energy saving is required. Even with a 10% efficiency gain, the capital would be saved in only 1000 operating hours. Efficiency gains of between 20% and 70% are often possible in many fan and pump applications.

Graph for an 11kW 4 pole motor with a pump/fan load type. Source: GAMBICA VSD Group, 2010

## Fixed Speed Control

It is not always appropriate to consider variable speed control and there are many applications that can be run with a fixed speed control method (Motor Contactors or Soft Starters for example). A fixed speed control should be considered where;

- The load demands maximum motor speed
- Mechanical constraints do not permit speed variation
- Financial considerations (e.g. Energy costs) do not justify payback of a VSD

In these cases, the simplest and most effective method to reduce energy consumption is to switch off the motor when it is not required.

By combining low voltage switchgear into well designed systems, significant energy savings can be achieved, and these savings are directly related to the amount of time the motor is switched off.

Typical techniques and applications are :-

- Level, Flow, Humidity, Temperature and Proximity Sensors can all be used to detect when a system or motor is required to operate
- PLC's (Programmable Logic Controllers) can be used to build 'intelligence' within a system. They can be programmed to predetermined schedules, or react to sensors inputs, and to ensure the motors only operate when required
- Soft Starters allow motors to be stopped and restarted many times per hour, whilst reducing the mechanical stresses and wear normally associated with direct on line starting. Current inrush can also be reduced by typically 50%

## System Efficiency

Selection of motors and drives should be considered as only a part of the overall gains to be made. It is important to consider efficiency of the overall system, from the input of electrical energy to the useful output (air pressure, water flow rate etc). Maximising the reduction in operating costs can only be achieved through careful system design to achieve maximum efficiency gains, e.g.

- Motor sizes can be reduced if drive train is more efficient
  - Optimisation of the driven equipment
  - Optimisation of power transmission train (gearbox, belts and pulleys)
- VSD can eliminate the need for a gearbox, increasing system efficiency
- VSD operate at almost unity power factor - reducing reactive power charges and increasing overall efficiency

## Specifying

As the energy cost is by far the most significant part of the lifecycle cost, it is recommended when specifying or purchasing a motor driven system to request not only a quote for the purchase cost, but also the annual operating cost. A lower purchase cost may mean higher energy bills and greater life-cycle costs. To support this process it is important to have a clear expectation of the operating regime of the motor.

## Drivers

As well as the financial benefit of using more efficient drives and motors, it will assist in compliance with or is required by

Enhanced Capital Allowances (ECA)	A tax allowance available when purchasing approved motors and drives: <a href="http://www.eca.gov.uk/">http://www.eca.gov.uk/</a>
Carbon Reduction Commitment (CRC)	A mandatory cap and trade scheme for energy users <a href="http://www.decc.gov.uk/en/content/cms/what_we_do/lc_uk/crc/crc.aspx">http://www.decc.gov.uk/en/content/cms/what_we_do/lc_uk/crc/crc.aspx</a>
ISO 16001 Energy Management	An international management standard requiring monitoring and continuous improvement of energy management
Energy Performance of Buildings (EPBD)	Energy performance certification requirement <a href="http://www.communities.gov.uk/epbd">www.communities.gov.uk/epbd</a>
Part L Building Regulations	See documents L2A and L2B at <a href="http://www.planningportal.gov.uk/england/professionals/buildingregs/technicalguidance/bcapproveddocumentslist/">http://www.planningportal.gov.uk/england/professionals/buildingregs/technicalguidance/bcapproveddocumentslist/</a>

Further GAMBICA / REMA publications are available online at

<http://www.gambica.org.uk/Publications>

<http://www.beama.org.uk/en/other-associations/rema.cfm>



AUTOMATION  
INSTRUMENTATION & CONTROL  
LABORATORY TECHNOLOGY

### **GAMBICA**

Broadwall House, 21 Broadwall  
London, SE1 9PL  
Tel: +44 (0)20 7642 8080

[www.gambica.org.uk](http://www.gambica.org.uk)



ROTATING ELECTRICAL  
MACHINES ASSOCIATION

### **REMA (A BEAMA Association)**

Westminster Tower, 3 Albert Embankment  
London, SE1 7SL  
Tel: +44 (0)20 7793 3006

<http://www.beama.org.uk/en/other-associations/rema.cfm>